

## CLAIMS

1. A switching power source apparatus comprising:

5 a first series circuit being connected to each end of a DC power source and including a primary winding of a transformer and a main switch those are connected in series;

a rectifying-smoothing circuit to rectify and smooth a voltage that is outputted from a secondary winding of the transformer when the main switch is turned on;

10 a second series circuit being connected to each end of the main switch or to each end of the primary winding of the transformer and including an auxiliary switch and a clamp capacitor those are connected in series;

15 a third series circuit being connected to each end of the main switch and including a first diode and a snubber capacitor those are connected in series;

a fourth series circuit being connected to a node between the first diode and the snubber capacitor and a node between the auxiliary switch and the clamp capacitor and  
20 including an auxiliary winding of the transformer and a second diode those are connected in series; and

a control circuit to alternately turn on/off the main switch and auxiliary switch, wherein

25 the snubber capacitor is discharged through the auxiliary winding to the clamp capacitor when the main switch is turned on; and

the snubber capacitor is charged when the main switch is turned off, to relax the inclination of a voltage increase of the main switch.

2. The switching power source apparatus of claim 1,  
wherein

the control circuit is configured to turn on the  
auxiliary switch to saturate magnetic flux in a core of the  
5 transformer and

turn off the auxiliary switch to make the main switch  
conduct zero-voltage switching as an exciting current  
increases.

10 3. The switching power source apparatus of claim 1 or 2,  
wherein the rectifying-smoothing circuit has

a fifth series circuit including the secondary winding  
and a tertiary winding of the transformer,

a sixth series circuit being connected to each end of  
15 the fifth series circuit and including a first rectifying  
diode and a smoothing capacitor, and

a second rectifying diode being connected to a node  
between the secondary winding and the tertiary winding and a  
node between the first rectifying diode and the smoothing  
20 capacitor.

4. The switching power source apparatus of claim 3,  
wherein the primary and secondary windings of the transformer  
are wound around the core of the transformer so as to provide  
25 a leakage inductance;

the primary and tertiary windings of the transformer are  
wound so as to provide a leakage inductance that is smaller  
than the leakage inductance provided by the primary and  
secondary windings; and

30 the primary and auxiliary windings of the transformer

are wound so as to provide a leakage inductance that is smaller than the leakage inductance provided by the primary and secondary windings and larger than the leakage inductance provided by the primary and tertiary windings.

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5. The switching power source apparatus of claim 4, wherein a magnetic path of the core of the transformer has a portion with reduced cross-sectional area.

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6. A switching power source apparatus comprising:

a first series circuit being connected to each end of a DC power source and including a primary winding of a transformer and a main switch those are connected in series;

15 a rectifying-smoothing circuit to rectify and smooth a voltage that is outputted from a secondary winding of the transformer when the main switch is turned off;

a second series circuit being connected to each end of the main switch or to each end of the primary winding of the transformer and including an auxiliary switch and a clamp capacitor those are connected in series;

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a third series circuit being connected to each end of the main switch and including a first diode and a snubber capacitor those are connected in series;

a fourth series circuit being connected to a node between the first diode and the snubber capacitor and a node between the auxiliary switch and the clamp capacitor and including an auxiliary winding of the transformer and a second diode those are connected in series; and

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a control circuit to alternately turn on/off the main switch and auxiliary switch, wherein

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the snubber capacitor is discharged through the auxiliary winding to the clamp capacitor when the main switch is turned on;

the clamp capacitor is discharged through the secondary  
5 winding to the rectifying-smoothing circuit when the auxiliary switch is turned on; and

the snubber capacitor is charged when the main switch is turned off, to relax the inclination of a voltage increase of the main switch.

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7. The switching power source apparatus of claim 6, wherein the rectifying-smoothing circuit has a series circuit of a rectifying diode and a smoothing capacitor that is connected to each end of the secondary winding of the  
15 transformer.

8. The switching power source apparatus of claim 7, wherein the primary winding and secondary winding of the transformer are wound around a core of the transformer so as  
20 to provide a leakage inductance, and the primary winding and auxiliary winding of the transformer are wound so as to provide a leakage inductance that is larger than the leakage inductance provided by the primary winding and secondary winding.

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